2015

# FSAE Rear Differential Carrier

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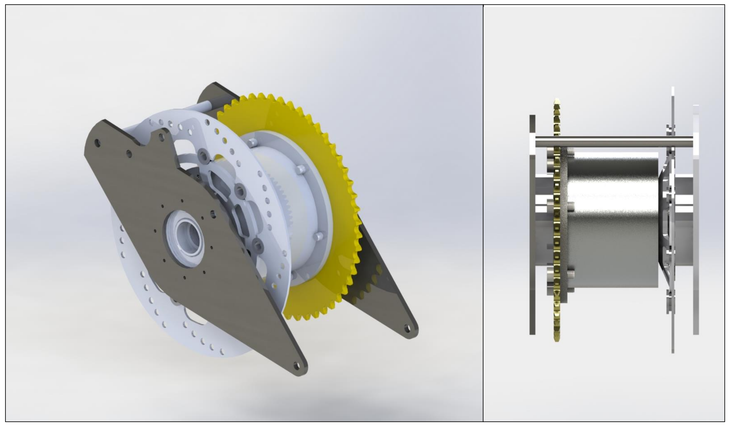
MECHANICAL AND NUCLEAR

# FSAE Rear Differential Carrier

CAPSTONE DESIGN EXPO 2015

## Design

- 1/4” 4130 alloy steel chosen because it was in stock
- Design to incorporate turnbuckle tensioners to adjust chain
- Bearing selected to meet size and performance parameters
- Double-sealed needle bearing to keep oil from leaking out of the differential
- 5mil nickel sleeves between all bearing surfaces to prevent steel-steel wear
- Chamfer bolt holes to eliminate stress concentrations
- Use grade 12.9 bolts on all assemblies for maximum reliability



## Analysis

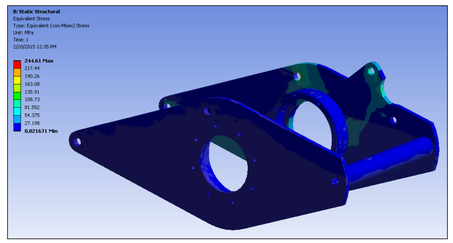
- Used finite element analysis to determine if design was sufficient
- Each plate was analyzed separately due to nodal constraints in ANSYS
- Assuming maximum acceleration of 2G and deceleration of 8G
- With 75/25 brake bias, 2G braking force on rear caliper
- Acceleration creates forces of approximately 13,500N
- Rounded to 15,000N to improve safety

Results of ANSYS analysis:
Acceleration (Bearing load):

| | |
|---|---|
| Peak stress (Von Mises) (without hole chamfer) | 554.2 MPa |
| Peak stress (Von Mises) (with chamfered hole) | 351.4 MPa |
| Peak deformation | 0.859 mm |

Braking:

| | |
|---|---|
| Peak stress (Von Mises) (without hole chamfer) | 244.61 MPa |
| Peak stress (Von Mises) (with chamfered hole) | 135.9 MPa |
| Peak deformation | 0.116 mm |

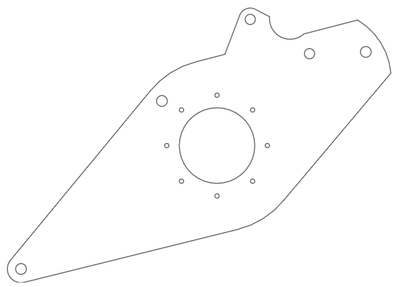



4130 alloy steel properties:

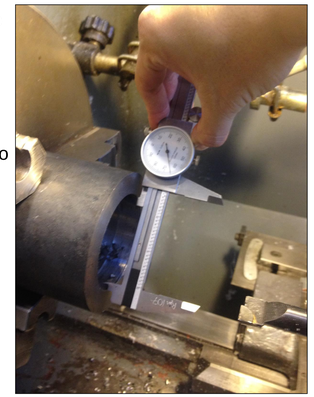
Yield strength: 430 MPa
Ultimate strength: 670 MPa

## Manufacturing

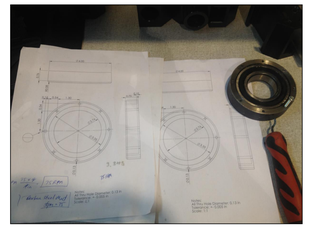
- Bearing holders machined in-house using slab of 1018 alloy steel
- The rod was drilled for a 1” diameter then bored until specific bore was achieved.
- Bore size confirmed frequently to ensure precise tolerances
- 8 holes drilled in bearing holder for assembly to carrier plates
- 4130 alloy plates outsourced to be waterjetted
- Plate holes chamfered by hand filing
- Diff housing internal splining removed with lathe to accommodate needle bearings



Above: CAD DXF drawing for waterjetting



Above: Measurement of the bore (corresponds to bearing O.D.)



## Constraints & Successes

- Minimal Factor of Safety – 2
- Bolt holes for Wil-120-5453 caliper
- Fit within the rear frame of the FSAE car
- Must last for 2 years per FSAE specifications

## Future Work?

- Observe performance of carrier in race conditions
- Determine ideal locations to remove material to decrease weight
- Paint to inhibit corrosion and match car aesthetics

Above: Final waterjetted brake side mount

VCU School of Engineering

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